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Some Effects of Predaceous Birds and Ants on the Western Spruce Budworm on Conifer Seedlings

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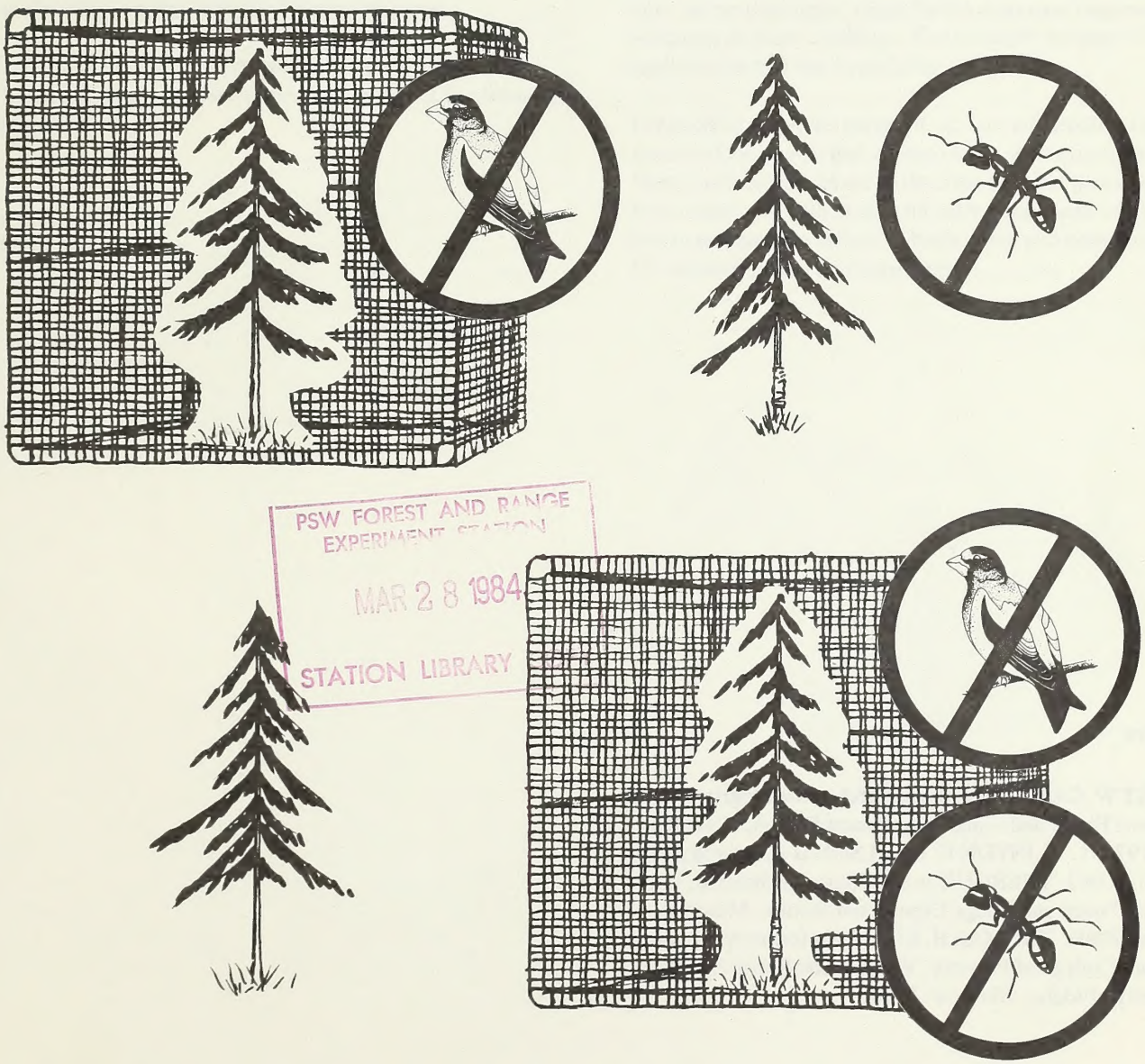

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Abstract

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Effects of predaceous birds and ants on the western spruce budworm, *Choristoneura occidentalis,* were studied on seedlings of western larch and Douglas-fir in western Montana. On western larch, both birds and ants reduced survival of larval budworm (instars IV-VI). On Douglas-fir, larval survival on one site was reduced by ants but not by birds. On a second site, neither birds nor ants had any effect on larval survival on Douglas-fir. Ants, but not birds, continued to have a major effect on the survival of budworm pupae.

KEYWORDS: Predator-prey relations, predators (insect) (-forest pest control, western spruce budworm, *Choristoneura occidentalis*.

Introduction

Birds and ants were major predators of the western spruce budworm, *Choristoneura occidentalis* Freeman, among populations studied in Washington and Idaho on about 9-m-tall Rocky Mountain Douglas-fir, *Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco, and grand fir, *Abies grandis* (Dougl. ex D. Don) Lindl. (Campbell and others in press.) In western Montana, predaceous birds continued to be effective in destroying budworm pupae on branches approximately 20 m above the ground. Ants, however, had no discernible effect on the pupae on these higher branches (Campbell and Torgersen 1983). From these results, we concluded that birds were the dominant budworm predators in the upper crowns of taller host trees. Current studies in western Montana suggest that budworm larvae and pupae exhibit an exceptionally low survival rate on trees less than 2 m tall; and we speculated that ants, rather than birds, might be the dominant budworm predators on these seedlings. The principal purpose of this study was to test that hypothesis.

For budworm cohorts on small, $\leq$ 1-m-tall seedlings of two species (Douglas-fir and western larch, *Larix occidentalis* Nutt.), our objectives are to describe the effects of excluding birds, ants, and both groups on subsequent budworm density; and to evaluate the effects of birds, ants, and both groups on the survival rate of budworm pupae.

Method

The study was conducted in 1982 in the vicinity of Chamberlain and Pearson Creeks, about 90 km (56 mi) northeast of Missoula, Mont. Both sites are at about the 1 025-m (3,420 ft) elevation above mean sea level. The Pearson Creek site is about 8 km (5 mi) east of Chamberlain Creek. Both sites were logged in 1961 as seed tree regeneration cuts, and both were reasonably well stocked with western larch and Douglas-fir regeneration (about 1,750 trees per ha (700 trees per acre): 66 percent western larch and 34 percent Douglas-fir). Both sites were ecologically and physically similar on north-facing 20- to 40-percent slopes within the *Abies lasiocarpa/Xerophyllum tenax* habitat type (Pfister and others 1977).

At each site, 40 Douglas-fir seedlings and 40 western larch seedlings about 1 m (39 in) tall were selected for study. Within each species, the boles of half the seedlings were banded with a sticky barrier below the base of the live crown. Above these barriers, foliage was pruned to eliminate any possible bridges that ants might use to travel to and from these seedlings. Birds were excluded from half of the banded trees and half of the unbanded ones by 3/4-m^3 (about 20-ft^3) cages made from 1/2-in IPS polyvinyl pipe and 1- x 2-cm (about 0.5- x 1-in) polypropylene screen (fig. 1) (Campbell and others 1981). On each site and host species, all treatments (ants excluded, birds excluded, both groups excluded, and controls) were completely randomized. The treatments were applied when the bulk of the budworm population was entering instar IV.

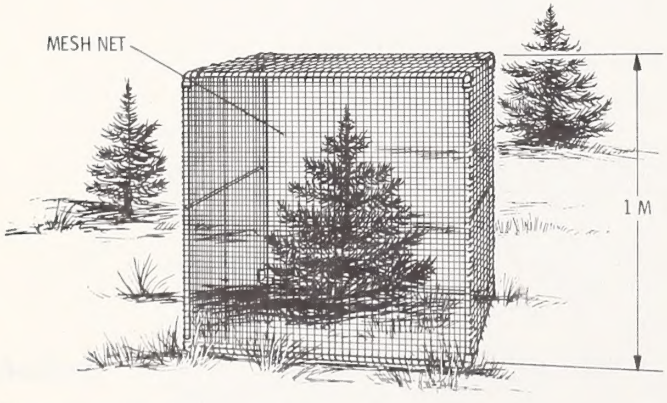

Figure 1.—Bird exclusion treatment.

Although the cage mesh did not appear to present a barrier to potential airborne insect enemies of the budworm, the cages may have interfered with some invertebrates. The sticky barriers would also prevent any crawling invertebrates on the ground from reaching the crowns of the treated seedlings. Significantly, however, ants are the only invertebrate group we have observed preying on the budworm in the Pacific Northwest (Campbell and others in press).

After pupation commenced, budworm pupae were collected from nearby populations by clipping twigs containing individual pupae. Two twigs were wired to branch tips on each seedling. For each site and host species, 20 pupae were installed on the 10 seedlings in each treatment category. A subsequent observation on the fate of these planted pupae provided a basis for estimating pupal survival from predation. Estimates produced by this method have been statistically indistinguishable from the much more labor-intensive effort needed to establish this rate among naturally occurring insects (Campbell and others 1982).

Two weeks after placement of the pupae-bearing twigs, we determined the status of these pupae. At the same time we also counted all naturally occurring budworms (larvae, pupae, and pupal exuviae) on each seedling.

All reported differences are based on Chi-square comparisons. To provide a more conservative test, we calculated Chi-square with Yates' correction (Dixon and Massey 1969).

Results and Discussion

Naturally Occurring Budworm

The total of all budworms (larvae, pupae, and pupal exuviae) found on seedlings in each treatment category (birds, ants, or both groups excluded, and controls) is shown for each site and host species in table 1. At the time of this final seedling examination, 36 percent of the 511 naturally occurring budworm were pupal exuviae and 12 percent were larvae. The remaining 52 percent were pupae. We infer from these percentages that most of the naturally occurring insects had pupated within just a few days of this final examination. Thus, differences in budworm densities among treatments were determined principally between instar IV and pupation.

On western larch at both sites, all other treatments contained significantly fewer budworms than were found on seedlings where both birds and ants had been excluded ($p < .05$). Thus, on this species both birds alone and ants alone had independent effects on budworm density.

On Douglas-fir in Chamberlain Creek, seedlings where birds had been excluded contained fewer budworms than those where both groups had been excluded ($p < .001$). Densities did not differ, however, between seedlings where ants had been excluded and those where both groups had been excluded. At this site ants therefore had a major effect on budworm density on Douglas-fir seedlings, whereas birds had no effect.

Neither birds nor ants had any effect on budworm density on Douglas-fir seedlings at Pearson Creek.

Table 1—Western spruce budworms found on control seedlings and on seedlings after birds, ants, or both groups had been excluded

Place	Host species	Treatment	Insects found[1]
Chamberlain Creek	western larch	Control	18 a
Chamberlain Creek	western larch	Ax[2]	42 b
Chamberlain Creek	western larch	Bx[3]	30 ab
Chamberlain Creek	western larch	ABx[4]	77 c
Chamberlain Creek	Douglas-fir	Control	24 a
Chamberlain Creek	Douglas-fir	Ax	94 b
Chamberlain Creek	Douglas-fir	Bx	20 a
Chamberlain Creek	Douglas-fir	ABx	81 b
Pearson Creek	western larch	Control	11 a
Pearson Creek	western larch	Ax	16 a
Pearson Creek	western larch	Bx	15 a
Pearson Creek	western larch	ABx	38 b
Pearson Creek	Douglas-fir	Control	6 a
Pearson Creek	Douglas-fir	Ax	13 a
Pearson Creek	Douglas-fir	Bx	13 a
Pearson Creek	Douglas-fir	ABx	13 a

[1] Insect densities in the same place and on the same species that are followed by the same letter are not significantly different.
[2] Ax = ants excluded.
[3] Bx = birds excluded.
[4] ABx = both groups excluded.

Budworm Pupae

The fate of pupae placed on seedlings in each treatment category is shown for each site and host species in table 2.

At both sites and on both host species, missing pupae on control seedlings called "Control" did not differ from those where birds had been excluded (Bx). Thus, birds had no effect on the disappearance rate of these pupae. For further analysis, results have been pooled for insects found in these two categories (control + Bx) on each site and host species. Similarly, at both sites and on both host species, missing pupae on seedlings where ants had been excluded (Ax) did not differ from those where both groups had been excluded (ABx). Again, for further analysis, results from the two categories have been pooled (Ax + ABx).

At both sites and on both host species, more pupae were missing on seedlings that had been exposed to ants (control + Bx) than on those protected from ants (Ax + ABx) ($p < .05$ on Douglas-fir in Chamberlain Creek; $p < .01$ elsewhere). At both sites, ants had a major effect on the disappearance rate of pupae. In Chamberlain Creek, 49 percent of the pupae disappeared from unprotected seedlings versus 19 percent from protected ones. In Pearson Creek, the comparable figures are 65 percent disappearance from unprotected seedlings versus 21 percent on protected ones.

Table 2—Fate of pupae placed on control seedlings and on seedlings protected from birds, ants, and both groups

Place	Host species	Treatment	Total pupae	Missing	Other
Chamberlain Creek	western larch	Control	23	9	14
Chamberlain Creek	western larch	Ax	18	3	15
Chamberlain Creek	western larch	Bx	22	13	9
Chamberlain Creek	western larch	ABx	18	2	16
Chamberlain Creek	western larch	[Control + Bx]	45	22	23
Chamberlain Creek	western larch	[Ax + ABx]	36	5	31
Chamberlain Creek	Douglas-fir	Control	20	11	9
Chamberlain Creek	Douglas-fir	Ax	22	8	14
Chamberlain Creek	Douglas-fir	Bx	20	9	11
Chamberlain Creek	Douglas-fir	ABx	20	2	18
Chamberlain Creek	Douglas-fir	[Control + Bx]	40	20	20
Chamberlain Creek	Douglas-fir	[Ax + ABx]	42	10	32
Pearson Creek	western larch	Control	21	14	7
Pearson Creek	western larch	Ax	20	5	15
Pearson Creek	western larch	Bx	20	14	6
Pearson Creek	western larch	ABx	20	3	17
Pearson Creek	western larch	[Control + Bx]	41	28	13
Pearson Creek	western larch	[Ax + ABx]	40	8	32
Pearson Creek	Douglas-fir	Control	20	12	8
Pearson Creek	Douglas-fir	Ax	21	5	16
Pearson Creek	Douglas-fir	Bx	20	13	7
Pearson Creek	Douglas-fir	ABx	20	4	16
Pearson Creek	Douglas-fir	[Control + Bx]	40	25	15
Pearson Creek	Douglas-fir	[Ax + ABx]	41	9	32

Implication

Both birds and ants had an effect on the budworms on conifer seedlings. In particular, birds appear to have removed some of the late instars and, possibly, some of the pupae from seedlings of western larch. Ants appear to have removed some of the larvae from seedlings of both western larch and Douglas-fir. Ants continued to have a major effect on the survival of planted budworm pupae; birds had no effect on these pupae.

These results leave little doubt that ants were far more important than birds as predators of the western spruce budworm on the conifer seedlings in Montana. Stands at both Pearson Creek and Chamberlain Creek were regenerated through seed tree cuts—silvicultural systems appropriate for those sites. If the density of ants increased following the harvest, subsequent increased predation by the ants may give developing conifer seedlings some additional protection from the western spruce budworm.

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